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Research notes: Effect of soybean plant age on the expression of antibiosis to corn earworm

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1) Evaluation of soybean germplasm for resistance to corn earworm--I.*

Corn earworm (*Heliothis zea* Boddie) is one of the most destructive pests of soybeans (*Glycine max* [L.] Merr.) and its infestation sometimes can cause complete crop loss (Turnipseed, 1973). This pest feeds on both the foliage and developing seeds in the pods. Soybeans become primary host as corn and cotton become more mature and consequently less attractive for oviposition (Freeman *et al.*, 1967). Each larva is capable of damaging 6 to 8.2 pods and 7.1 seeds between 4th and 6th instars, both inclusive (Boldt *et al.*, 1975; Smith and Bass, 1972). The objective of the present investigation was to identify germplasm resistant to this pest.

One hundred seventy-four cultivars belonging to Maturity Groups 00-IV were planted in three replications in the screen house (108'x72'x15') during 1974. Ten seeds of each cultivar were sown on May 14, the seeds being 2" apart within the row and rows being 36" apart. Screen house was infested by releasing 2,244 corn earworm moths. The moth releases were started on June 26 and continued until September 23. Plants were harvested at maturity and the number of undamaged and damaged pods was recorded for each cultivar. Data were analyzed statistically by employing ANOVA; Duncan's Multiple Range Test was used to test significant difference between the means.

*This is part of a CSRS/USDA funded project.

The mean numbers of undamaged and damaged pods/plant for each cultivar are given below. (Means which are not followed by the same letter are significantly different at the 0.05 probability level.)

Table 1

Mean number of undamaged and damaged pods for different soybean cultivars

Cultivar	Undamaged pods	Damaged pods	Cultivar	Undamaged pods	Damaged pods
			Maturity Group 00		
Norman	2.7a	1.1a	Ogemaw	5.2a	2.5a
Morsoy	3.0a	2.7a	Altona	5.4a	3.0a
Pagoda	3.0a	2.5a	Ada	5.6a	5.9b
Crest	3.9a	0.7a	Flambeau	5.7a	2.0a
Hidatsa	4.0a	2.0a	Manitoba Brown	5.8a	2.3a
Acme	4.8a	0.7a	Agate	6.4a	1.6a
Pando	4.9a	5.0b			
			Maturity Group 0		
Norchief	1.9a	3.3a	Hardome	4.7a	1.6a
Goldsoy	2.6a	1.1a	Merit	5.7a	2.2a
Capital	3.6a	5.6a	Grant	8.8a	5.5a
Mandarin Ottawa	4.1a	3.9a	Kabott	11.5a	3.8a
Poland Yellow	4.6a	2.7a			
			Maturity Group I		
Manchuria	0.2a	1.3ab	Pridesoy	4.3ab	2.2a-c
Portugal	1.5ab	1.7a-c	Chippewa 64	5.4ab	2.1a-c
Harly	1.8ab	0.2a	EarlyAna	5.5ab	1.4a-c
Norsoy	1.9ab	1.8a-c	Cayuga	6.1a-c	0.4a
Ontario	2.4ab	1.6a-c	Manchu Montreal	6.2a-c	3.5a-c
Rampage	2.4ab	1.2ab	Ottawa	6.3a-c	2.9a-c
Renville	2.7ab	0.9ab	Mandarin	6.5a-c	4.7bc
Giant Green	2.8ab	0.1a	OAC 211	9.2a-d	3.2a-c
SRF 150	3.0ab	1.3ab	A-100	9.3a-d	3.2a-c
Anoka	3.1ab	1.9a-c	Bombay	10.5b-d	1.5a-c
Blackeye	3.2ab	1.2ab	Kagon	10.9b-d	4.0a-c
Medium Green	3.2ab	1.6a-c	Blackhawk	11.0b-d	2.3a-c
Burwell	3.5ab	1.4a-c	Elton	11.3b-d	1.4a-c
Monroe	3.5ab	3.2a-c	Chippewa	15.5cd	7.4c
Mendota	3.6ab	1.5a-c	Hoosier	15.6cd	6.5bc
Hark	3.7ab	0.7ab	Disoy	17.2d	5.4a-c

Table 1 (cont'd)

Cultivar	Undamaged pods	Damaged pods	Cultivar	Undamaged pods	Damaged pods
		Maturity Group II			
Henry	2.6a	0.1a	Zinman 533	6.9ab	5.6cd
Goku	2.7a	0.4a	Manchu 606 Wis.	7.0ab	7.4de
Bansei (Ames)	4.6ab	0.6a	Manchu Kota	7.1ab	2.3a-c
Manchu 3 Wis.	5.1ab	2.6a-c	Lindarin	7.2ab	2.1a-c
Magna	5.4ab	1.6a-c	Prize	7.4ab	2.9a-c
Madison	5.8ab	2.1a-c	Bansei	7.8ab	0.3a
Harwood	6.0ab	2.1a-c	Manchu Hudson	8.8ab	5.4cd
Corsoy	6.5ab	4.1a-d	Beeson	9.8a-c	3.8a-d
Kanum	6.2ab	1.7a-c	Harosoy	7.9ab	0.8ab
Provar	6.5ab	2.9a-c	Black Eyebrow	9.9a-c	3.1a-c
Korean	10.1a-c	5.3b-d	Amsoy	14.3a-c	2.1a-c
Lindarin 63	11.2a-c	2.7a-c	Manchu Madison	15.1a-c	3.0a-c
Kanro	11.4a-c	0.7a	Hawkeye	17.7a-c	2.6a-c
Protana	11.5a-c	3.0a-c	Hawkeye 63	20.1bc	1.8a-c
Harosoy 63	11.9a-c	2.3a-c	Funman	24.6cd	10.1e
Mukden	13.3a-c	1.3a-c	Amsoy 71	32.6	1.9a-c
		Maturity Group III			
Guelph	0.1a	9.0d	Bavender Sp. B	11.5a-d	1.6ab
Little Wonder	4.3ab	0.6a	Lincoln	13.1a-d	1.5a
Cloud	5.0a-c	1.9ab	Chusei	13.8a-e	2.4ab
Jogun	5.2a-c	0.5a	Kanrich	14.4a-e	0.3a
Adams	5.5a-c	1.1a	SRF 350	14.9a-e	2.3ab
AK (Harrow)	5.6a-c	1.1a	Bavender Sp. B	15.0a-e	2.3ab
Ennis 1	6.9a-c	0.3a	Bavender Sp. C	15.0a-e	7.8cd
Kura	8.0a-d	1.0a	Mingo	15.7a-e	1.2a
Mandell	8.0a-d	0.6a	Adelphia	21.7a-e	1.9ab
Jogun (Ames)	8.5a-d	0.6a	Osaya	22.5a-e	5.1bc
Miller 67	8.8a-d	0.9a	Calland	25.2b-e	1.8ab
Ilsoy	8.8a-d	0.8a	Manchuria 20173	25.2b-e	2.2ab
Ford	8.8a-d	2.0ab	Manchu (Laf.)	26.8b-e	0.6a
Pennsoy	9.0a-d	1.4a	Manchuria 13177	28.4c-e	8.3d
Dunfield	9.6a-d	0.9a	Fugi	28.5c-e	2.2ab
Illington	9.0a-d	2.7ab	Manchu (Laf.) B	31.5de	3.2ab
Illini	10.5a-d	2.0ab	Columbia	36.5e	1.3a
Granger	10.8a-d	2.5ab	Mansoy	37.0e	3.6ab
Manchu	11.1a-d	2.4ab			
		Maturity Group IV			
SRF 425	6.1a	0.8a-e	AK (FC 30.761)	22.7a-j	0.2a-c
Funk Delicious	6.5ab	0.7a-d	Norredo	23.1a-j	1.0a-f
Boone	6.7ab	0.2ab	Hurrelbrink	23.2a-j	0.5a-c
Carlin	7.8a-c	0.5a-c	Patterson	24.9a-j	1.3a-f
Morse	8.1a-d	0.4ab	Kahala	26.3a-j	3.5d-i
Hahto (Michigan)	8.6a-e	1.6a-f	SRF 450	26.4a-j	1.9a-h

Table 1 (cont'd)

Cultivar	Undamaged pods	Damaged pods	Cultivar	Undamaged pods	Damaged pods
		Maturity Group IV (cont'd)			
Kingston	11.5a-e	1.4a-f	HP 963	27.7a-j	1.0a-f
Polysoy	12.2a-f	0.03a	Delmar	28.0a-j	4.6h-j
Harbinsoy	12.7a-f	1.3a-f	Bethel	29.0a-j	3.9f-i
Chief	13.3a-f	2.7a-i	Wye	30.0a-j	1.4a-f
Perry	14.2a-g	2.1a-h	Green and Black	31.3b-j	6.6j
Clark	14.8a-g	1.8a-h	Patoka	31.9c-j	4.5h-j
Cutler	15.1a-g	2.4a-i	Emperor	32.7c-j	3.0b-i
Higan	15.5a-g	1.7a-g	Hong Kong	32.8d-j	1.5a-f
Hokkaido	15.7a-g	1.7a-g	Macoupin	34.6d-j	2.7a-i
Fabulin	16.7a-g	1.8a-h	Kent	35.3e-j	3.7e-i
Kaikoo	17.0a-g	3.0b-i	D67-3297	36.1e-j	1.1a-f
Aoda	17.3a-g	1.0a-f	Cypress #1	37.1f-j	5.0ij
Ebony	18.0a-h	1.1a-f	Kingwa	37.2f-j	1.7a-g
Kailua	18.2a-h	1.5a-f	AK (Kansas)	38.4g-j	1.2a-f
Cutler 71	18.9a-h	2.0a-h	Columbus	42.1h-j	1.2a-f
Midwest	18.9a-i	2.5a-i	Custer	44.4ij	2.0a-h
Gibson	20.7a-i	0.8a-e	Oksoy	45.4ij	1.7a-g
Jefferson	20.8a-j	1.8a-h	Mokapu Summer	46.0j	2.6a-i
Clark 63	22.0a-j	3.9f-i	Peking	22.2a-j	0.6a-c
SRF 400	22.4a-j	3.4c-i			

Cultivars belonging to Maturity Groups 00 and 0 produced very few undamaged pods per plant because these cultivars suffered severe foliage and flower damage by H. zea. Significant differences were not observed for undamaged pods/plant for Maturity Groups 00 and 0 cultivars. However, 'Pando' and 'Ada' produced significantly more damaged pods than others in Maturity Group 00. Among Maturity Group I cultivars, 'OAC 211', 'A-100', 'Bombay', 'Kagon', 'Blackhawk', 'Elton', 'Chippewa', 'Hoosier' and 'Disoy' produced significantly more undamaged pods than others. However, 'Elton' produced the highest percentage of undamaged pods (89%) and 'Bombay' was a close second with 88%. 'Amsoy 71' and 'Funman' (Maturity Group II) produced 32.6 and 24.6 undamaged pods/plant respectively. These two cultivars have out-performed the others in their maturity group. However, Amsoy 71 and Funman produced 94.5% and 70.9% undamaged pods respectively. Amsoy 71 has certainly performed better than Funman. 'Mansoy' and 'Columbia' (Maturity Group III) produced 37.0 and 36.5 undamaged pods/plant respectively. However, the percentage of undamaged pods was 96.6 for Columbia and 91.1 for Mansoy.

Among Maturity Group IV cultivars 'Mokapu Summer' produced the highest number of undamaged pods/plant (46.0), followed closely by 'Oksoy' (45.4), 'Custer' (44.4), and 'Columbus' (42.1). The percentage of undamaged pods/plant was highest for Columbus. Soybean breeders, both public and private, may want to examine some of these entries more critically for developing resistant soybean cultivars.

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2) Evaluation of soybean germplasm for resistance to corn earworm--II.*

During 1975, 145 additional soybean (Glycine max [L.] Merr.) Plant Introductions and cultivars belonging to Maturity Groups 00-IV were evaluated in the screen house for corn earworm (Heliothis zea Boddie) resistance. The experimental procedures were the same as described in the previous article except the number of corn earworm moths released in the screen house; 2,872 moths (2,244 released in 1974) were released from June 24 to September 19, 1975. Since a positive phenotypic correlation between the number of pods per plant and yield has been reported by many scientists (Anand and Torrie, 1963; Hanson and Weber, 1961; and Weatherspoon and Wentz, 1934), it is hoped that Plant Introductions

*This is part of a CSRS/USDA funded project.

and cultivars capable of producing more undamaged pods under heavy infestation will be both resistant and high yielding.

The mean numbers of undamaged and damaged pods per plant for each Plant Introduction and cultivar are reported below. The means not followed by the same letter are significantly different at the 0.05 probability level according to Duncan's Multiple Range Test.

Table 1

Mean undamaged and damaged pods for different soybean Plant Introductions and cultivars

Plant introduction or cultivar	Undamaged pods/plant	Damaged pods/plant	Plant introduction or cultivar	Undamaged pods/plant	Damaged pods/plant
		Maturity Group 00			
PI 194.627	1.4a	9.5a-d	PI 258.387	4.0a	14.8b-e
PI 189.937	1.5a	9.4a-d	PI 189.906	4.0a	14.7b-e
PI 194.647	1.5a	7.4ab	PI 194.644	4.3a	12.1b-e
PI 180.519	2.1a	12.3b-e	PI 180.516	4.8a	12.2b-e
PI 232.998	2.1a	11.7b-e	PI 258.386	4.9a	13.7b-e
PI 361.086	2.2a	8.3ab	PI 154.190	5.1a	7.0ab
PI 297.550	2.2a	19.0de	PI 358.321A	5.2ab	11.2b-e
PI 189.877	2.3a	7.8ab	PI 180.525	5.6ab	14.4b-e
PI 232.999	2.4a	11.2b-e	PI 180.507	5.6ab	8.1ab
PI 257.431	2.4a	10.0a-e	PI 180.508	5.8ab	15.3b-e
PI 194.624	2.9a	7.2ab	PI 154.197	6.6ab	19.5e
PI 189.880	2.9a	14.0b-e	PI 232.997	7.3ab	13.5b-e
PI 238.923	3.2a	18.0c-e	PI 154.193	10.8b	14.2b-e
PI 153.314	3.2a	12.0b-e	PI 297.503	13.1c	14.4b-e
PI 189.886	3.5a	7.2ab	Portage	13.9c	1.1a
PI 257.430	3.6a	14.6b-e			
		Maturity Group 0			
PI 261.475	0.7a	9.5a	PI 297.506	3.2a	15.2a
PI 290.114	1.1a	9.7a	PI 257.434	3.5a	10.1a
PI 297.516	1.5a	8.9a	PI 290.121	3.8a	7.1a
PI 291.312	1.5a	7.5a	PI 290.145	3.8a	13.5a
PI 290.131	1.8a	7.3a	PI 290.157	3.8a	13.3a
PI 290.122	2.0a	10.4a	PI 323.586C	4.1a	13.4a
PI 290.140	2.1a	10.9a	PI 290.118	4.2a	12.0a
PI 290.144	2.3a	9.7a	PI 290.115	4.4a	16.7a
PI 290.135	2.3a	7.7a	PI 347.549	4.5a	9.5a
PI 297.509	2.3a	8.6a	PI 257.436	5.3a	10.4a
PI 297.546	2.4a	8.9a	PI 290.123A	5.4a	14.0a
PI 297.547	2.7a	9.9a	PI 290.116A	5.8a	11.2a
PI 291.311A	2.8a	6.8a	PI 257.433	6.2a	11.2a
PI 290.141	2.8a	8.4a	PI 290.129B	8.3a	12.3a
PI 290.132	3.0a	11.2a	PI 297.512	3.1a	12.8a

Table 1 (cont'd)

Plant introduction or cultivar	Undamaged pods/plant	Damaged pods/plant	Plant introduction or cultivar	Undamaged pods/plant	Damaged pods/plant
		Maturity Group I			
PI 189.916	0.5a	8.7a	PI 297.505	1.4a-d	6.2a
PI 290.124	0.5a	7.6a	PI 290.134	1.4a-d	10.3a
PI 253.658A	0.8ab	1.9a	PI 253.652C	1.5a-e	6.3a
PI 184.042	0.9ab	5.3a	Wirth	2.2a-f	7.6a
PI 253.652D	0.9ab	2.6a	PI 361.095	2.6a-f	14.7a
PI 319.538	1.0a-c	4.9a	PI 291.322	2.8a-f	10.9a
PI 319.536C	1.0a-c	5.5a	PI 253.653D	3.0a-f	9.0a
PI 248.509A	1.1a-c	8.4a	PI 291.311B	3.5a-f	5.9a
PI 291.281	1.1a-c	6.0a	Dunn	3.7b-f	7.4a
PI 291.283	1.1a-c	4.4a	PI 291.304	3.8b-f	7.5a
PI 153.255	1.3a-d	5.7a	PI 266.806A	4.1c-f	10.2a
PI 253.653C	1.3a-d	6.4a	PI 361.092	4.3d-f	17.8a
PI 319.535B	1.3a-d	4.9a	PI 291.303A	4.5ef	7.9a
PI 297.548	1.3a-d	15.3a	PI 347.552B	5.0f	16.6a
		Maturity Group II			
PI 291.299	0.5a	2.7a	PI 266.806	1.9ab	5.0a
PI 291.282	0.7a	4.6a	PI 291.327	2.2ab	5.4a
PI 291.302B	0.7a	6.1a	PI 261.474	2.3ab	1.3a
PI 291.279	0.8a	2.3a	PI 85.021	2.9ab	2.3a
Kanro	0.8a	2.3a	PI 266.085B	3.0ab	5.1a
PI 291.306A	0.9a	6.1a	Yellow Marvel	3.6ab	2.6a
PI 317.334A	1.0ab	4.0a	PI 297.544	3.7ab	3.3a
Seneca	1.1ab	3.8a	PI 297.545	3.8ab	6.5a
PI 261.472	1.3ab	3.8a	PI 291.302A	4.2ab	2.3a
PI 340.007	1.5ab	1.2a	PI 86.089	4.4a-c	7.9a
PI 291.315	1.6ab	2.8a	PI 291.295	4.7a-c	11.1a
PI 266.085A	1.8ab	9.5a	Wells	10.6c	5.2a
PI 297.543	1.9ab	6.5a			
		Maturity Group III			
PI 86.153	0.3a	2.1ab	PI 261.466	2.0ab	0.8a
PI 84.976	0.3a	1.2a	Ennis I	2.4ab	2.2a-c
PI 86.075	0.4a	0.6a	PI 339.995	2.6ab	0.9a
PI 91.120-3	0.6a	1.0a	PI 86.073	3.1ab	3.3a-d
PI 253.660B	0.6a	3.1a-d	PI 273.483A	3.2ab	1.0a
PI 291.306B	0.9a	1.0a	PI 85.456	3.7ab	3.2a-d
PI 86.425	1.2a	0.4a	PI 86.071	4.8a-c	1.0a
PI 273.483A	1.3a	1.0a	PI 339.868E	5.9a-d	1.4a
PI 86.482	1.5a	2.2a-c	PI 253.661A	7.3b-e	2.2a-c
PI 261.467	1.7ab	3.0a-d	Wayne	9.7c-e	6.1de
Wolverine	1.8ab	1.8ab			

Table 1 (cont'd)

Plant introduction or cultivar	Undamaged pods/plant	Damaged pods/plant	Plant introduction or cultivar	Undamaged pods/plant	Damaged pods/plant
		Maturity Group IV			
T141	2.4a	0.3a	D66.5566	17.2a-e	0.3a
T31	3.5ab	2.6a	T145	19.5a-e	0.2a
Sanga	6.9a-d	1.8a	PI 86.740	27.9b-f	0.6a
T207	7.1a-d	1.5a	PI 86.876	31.0c-g	2.1a
T240	10.1a-e	1.8a	Gibson	16.0a-e	1.0a

Soybean cultivar 'Portage' in Maturity Group 00 produced the highest number of undamaged pods and only 1.1 damaged pods/plant. Among all the Plant Introductions and cultivars tested in Maturity Group 00, Portage has outperformed the rest. Significant differences were not observed in any tested Plant Introduction or cultivar in Maturity Group 0 for either undamaged or damaged pods. The number of undamaged pods produced by the Plant Introductions or cultivars in Maturity Groups I, II, and III was very low; the highest number of undamaged pods (10.6) was produced by 'Wells'. PI 86.876 in Maturity Group IV produced the highest number of undamaged pods (31.0), followed closely by PI 86.740, which produced 27.9 undamaged pods/plant. The percentage of undamaged pods was higher, however, for PI 86.740 (97.9%) than PI 86.876 (93.3%). These data indicate that cultivar Portage and Plant Introductions PI 86.740 and PI 86.876 resist corn earworm damage better than other tested cultivars or Plant Introductions.

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3) Effect of soybean plant age on the expression of antibiosis to corn earworm.

It is expected that soybean (Glycine max [L.] Merr.) cultivars resistant to various insect pests shall play an important role in integrated pest management programs. Certain soybean cultivars have been shown to possess resistance to Mexican bean beetle (Epilachna varivestis Mulsant) (Van Duyn et al., 1971, 1972), bean leaf beetle (Cerotoma trifurcata Foster), striped blister beetle (Eplicanta vittata Fabricius) (Clark et al., 1972) and corn earworm (Heliothis zea Boddie) for leaf feeding (Beland and Hatchett, 1976; Joshi and Wutoh, 1976; Joshi, 1977; Hatchett et al., 1976). It has been suggested that 2 to 3 weeks age difference has considerable effect on the expression of antibiosis to corn earworm as expressed by low larval weight and higher larval mortality in cases of resistant genotypes. However, the behavior of the commercial cultivars was not consistent and the larval weights were generally higher (Hatchett et al., 1976; and Beland and Hatchett, 1976). The present investigation was undertaken to study the effect of plant age on the expression of antibiosis to corn earworm.

Materials and methods: Three Plant Introductions and three cultivars (PI 227.687, PI 229.358, ED 73.371, 'Shore', 'Wye' and 'Davis') were planted in the greenhouse on April 2, 1977. Promix was used as a seed bed material and the pH was adjusted by mixing 5 pounds of dolomite lime/cubic yard. Soybean cultivar Davis (Hatchett et al., 1976) and synthetic diet (supplied by Bio-Serv, Frenchtown, NJ) were used as checks. Two separate tests were conducted. First test of antibiosis was started on May 11, 1977 when most of the plants were in the 5th trifoliolate stage, but cultivars Shore and Wye were in flowering stage. Second test was started on June 20, 1977. Plants in Test 2 were 40 days older than in Test 1. PI 229.358, PI 227.687 and Davis were the only ones included in Test 2. Others could not be used due to the lack of fresh vegetative growth. Synthetic diet treatment was again included as check in Test 2. The mean temperature was 24.2°C (range 21-27°C) during Test 1 and 25.6°C (range 23-28°C) during Test 2. Three newly hatched larvae (< 24 hr old) were placed in 75.0 ml plastic lidded cups with moistened disc of paper toweling along with the excised leaflet of the uppermost fully expanded trifoliolate. The paper discs were moistened to help maintain high humidity for larvae and to retard water loss from the leaflets. Each treatment had 30 cups per treatment. After 72 hr, larvae were thinned to 1 per cup. The larvae were weighed on 16th day and pupae on 5th day after pupation in both tests. The duration of larval period, pupation period, larval mortality and total mortality were also recorded. Other techniques of feeding and rearing were the same as reported in the earlier publications (Joshi and Wutoh, 1976; Joshi, 1977).

Results and discussion: The effect of different feeding treatments on the growth and development of H. zea is given in Table 1. In Test 1, which represented leaf feeding from younger plants, larvae gained least weight on Shore (216 mg), although there was no significant difference in larval weight among Shore, ED 73.371, and PI 227.687. As expected, maximum larval weight was gained on synthetic diet (600 mg). However, no significant difference was observed in the larval weight for Wye and Davis (susceptible check). The larval weight on Davis was also not significantly different from PI 229.358 (resistant check). Larvae feeding on Shore and ED 73.371 passed through extended larval stage and spent 24.5 and 23.5 days respectively in larval stage. On the contrary, the larval duration was only 18.9 days on synthetic diet. The larval stage on Wye and Davis was 19.9 and 21.0 days, respectively, and were not significantly different from each other. The duration of the pupal stage was not influenced by any Plant Introduction or cultivar. However, the larvae raised on synthetic diet had extended pupal stage. The total mortality was very low on PI 229.358. The other resistant genotypes, however, showed higher mortality as compared to synthetic diet, Davis and Wye. The highest mortality was observed for ED 73.371 (43.3%), followed by PI 227.687 and Shore (30%).

Test 2 was started on June 20, 1977 on the same plants. The plants in Test 2 were more advanced in age, i.e., 40 days older than in Test 1. The data in Test 2 (Table 1) clearly indicates the H. zea larvae gained less weight when raised on the foliage of older plants. The larvae gained less weight on PI 229.358, PI 227.687 and Davis. The total mortality increased on the 2 Plant Introductions (PI 229.358 and PI 227.687) and decreased on Davis. These results are consistent with earlier studies (Hatchett et al., 1976; and Beland and Hatchett, 1976). The total mortality on PI 227.687 was 80% in Test 2 and only 30% in Test 1. Total H. zea mortality on different genotypes in this study was very low except for PI 228.687 in Test 2 (80%). Much higher mortalities have been reported by other investigators (Hatchett et al., 1976; and Beland and Hatchett, 1976). It is not clear whether the difference in total mortality is due to environmental conditions or variability in the vigor of the H. zea larvae of different females or both.

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4) Observations on a new important pest of soybeans.

In 1976, the alydid, Alydus pilosulus (H.-S.), was first recorded in small numbers on the research plots at Princess Anne, MD. But in 1977, it was observed in pest proportions and also a corid, Leptoglossus oppositus (Say), was recorded for the first time. Though the stink bugs were not observed to

Table 1

Treatment[+]	Larval weight[++] (mg)	Larvae pupated (#)	$\bar{X}$ days to pupation	Pupal weight[+++] (mg)	$\bar{X}$ days in pupation	Larval mortality (%)	Total mortality (%)
			Test 1				
Synthetic diet	600a*	29	18.9d*	432a*	15.4a*	3.3	6.7
Wye	470b	27	19.9cd	273bc	13.7b	10.0	10.0
Davis	402b-d	26	21.0c	288b	14.0b	13.3	20.0
PI 229.358	369cd	29	22.7b	278b	13.9b	3.3	6.7
PI 227.687	291de	24	22.6b	262b-d	14.1b	20.0	30.0
ED 73.371	231e	20	23.5ab	275bc	13.7b	33.3	43.3
Shore	216e	22	24.5a	235d	13.0b	26.7	30.0
			Test 2[++++]				
Synthetic diet	490a	28	14.7d	410a	10.3a	6.7	10.0
Davis	380b	28	19.5c	230b	9.9a	6.7	10.0
PI 229.358	250c	25	22.7b	210b	9.6a	16.7	20.0
PI 227.687	180d	14	23.0a	160c	9.3a	53.3	80.0

*Means not followed by the same letter were significantly different at the 0.05 probability level according to Duncan's Multiple Range Test.

[+]30 larvae/treatment.

[++]Mean weight of larvae on 16th day.

[+++]Mean weight of pupae on 5th day after pupation.

[++++]Plants 40 days older than in Test 1.

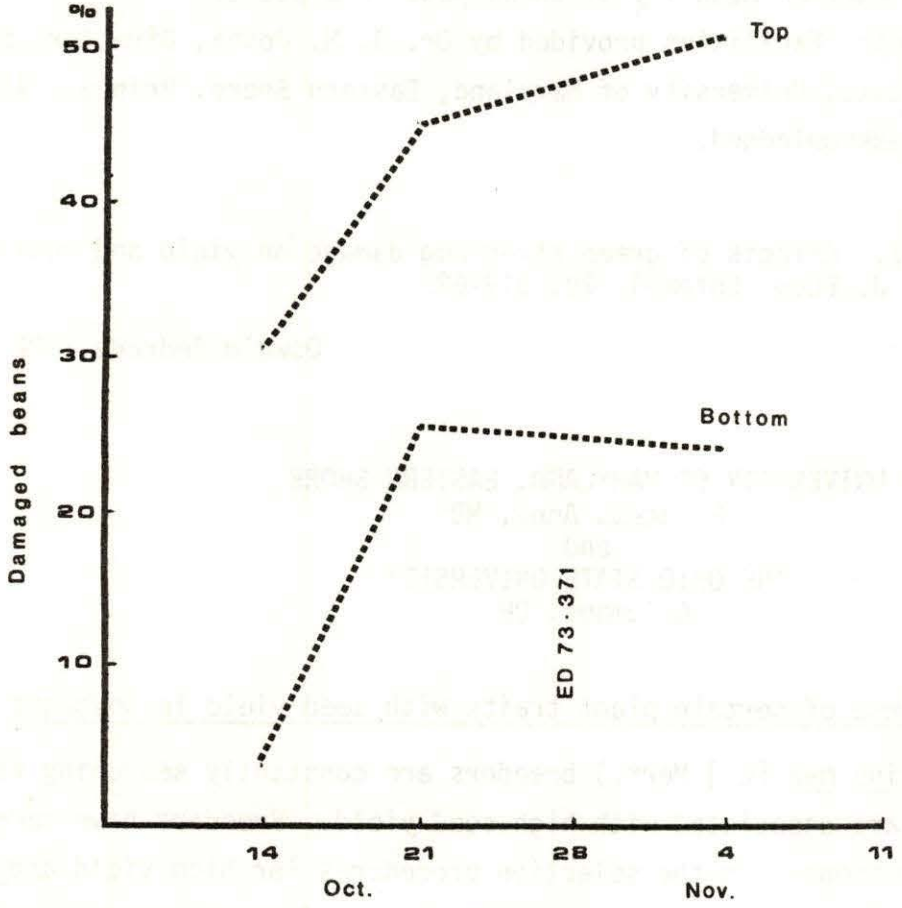

Fig. 1. Mean damaged beans from top and bottom of soybean plants.

be more numerous than in the previous years, the total damage from feeding by all the heteroptera was assessed by obtaining five yellow or green pods from the uppermost portion of the plant and five pods from the lowest part of the same plant; ten plants were sampled from a 9'x20' plot. The pods were shelled by hand and the beans examined for damage. The results are presented in Fig. 1.

Yeargan (1977) has shown that when four green stink bugs (*A. hilare*) were present per 0.3 m of row, the damaged pods were 36.5%. Our overall means, excluding the sample from ED 73.371, are 42.1% for the top and 17.9% for the bottom. No increase in damage at the bottom of the plant, in the last sample, could be due to the earlier maturity of these pods in a plant.

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1) Correlated response of certain plant traits with seed yield in soybeans.

Soybean (*Glycine max* [L.] Merr.) breeders are constantly searching for plant traits that are associated with high seed yield. Breeders have made use of correlated responses in the selection procedures for high yield and disease resistance, high protein and low oil content, and days to maturity and seed yield. Several plant traits such as lodging, plant height, shattering, maturity, etc. must be simultaneously taken into consideration in the selection process. It has been observed that plant height, late maturity and susceptibility to lodging are positively correlated with seed yield (Anand and Torrie, 1963; and Kwon and Torrie, 1964). Plant traits such as short stature and resistance to lodging have been reported to have association with seed yield (Byth *et al*., 1969). Low seed yield has been associated with indeterminate growth and glabrousness (Hartwig and Edwards, 1970). So far the study